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NASA Procedural Requirements

COMPLIANCE IS MANDATORY**NPR 7120.5C**Effective Date: March 22,
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Subject: NASA Program and Project Management Processes and Requirements

Responsible Office: Office of the Chief Engineer

[| TOC](#) | [Preface](#) | [Change_Log](#) | [Chapter1](#) | [Chapter2](#) | [Chapter3](#) | [Chapter4](#) | [Chapter5](#) |
[Chapter6](#) | [Chapter7](#) | [AppendixA](#) | [AppendixB](#) | [AppendixC](#) | [AppendixD](#) | [AppendixE](#) |
[AppendixF](#) | [AppendixG](#) | [AppendixH](#) | [AppendixI](#) | [AppendixJ](#) | [AppendixK](#) | [AppendixL](#) |
[AppendixM](#) | [AppendixN](#) | [AppendixO](#) | [ALL](#) |

Chapter 3. Common Project Management Requirements

3.1 Four-Part Project Management Process

3.1.a NASA projects are elements of a program and are investments that have defined goals objectives, requirements, LCC, a beginning, and an end. Projects vary significantly in their complexity, cost, and criticality. The Project Manager is responsible for the successful accomplishment of his/her project from formulation through implementation, and for customer satisfaction with the products and services delivered. The Project Manager is accountable to his/her Program Manager and to the Center Director for assigned projects. Project Managers are key members of the program management team, providing information and assisting the Program Manager in the execution of the integrated program.

3.1.b This chapter delineates the common requirements for the management of projects, described in terms of the four-part management process of paragraph 1.7.1. The requirements of the chapter apply specifically to projects *identified in Program Plans*. It is recognized that these projects contain lower-level project activities managed by designated responsible organizations. The cognizant Mission Directorates, Mission Support Offices, programs, projects, or Centers shall flow down the requirements of this document. The Project Manager should also review all Mission Directorate, Mission Support Office, program, and Center-level documents that might include requirements beyond those in this document.

3.1.c Managers of projects identified in a Program Plan shall meet all requirements outlined in this chapter *irrespective of the size of the project and the program* of which it is an element. Requests for deviations or waivers to NPR 7120.5C requirements shall be documented and submitted for approval to the Center Director, the Program Manager, Mission Directorate (or Mission Support Office), and the appropriate GPMC. The Project Manager should receive written authorization from the Office of Security and Program Protection for waiver of activities related to security. Prior to the NAR, these requests shall be documented in the NPR 7120.5C compliance matrix attached to a single deviation or waiver to assure proper routing and control.²² Deviations or waivers impacting formulation or requiring long lead-time shall be submitted individually early in formulation. Following the NAR, deviations or waivers shall be submitted individually to the approving authority described above. The compliance matrix, with approved deviations and waivers, shall be included as an appendix to the Project Plan.

²² The Compliance Matrix is provided as Appendix K.

3.1.d Project IT investments shall be separately planned for, evaluated in terms of Return on Investment (ROI), budgeted, and managed. Refer to Chapter 7 for requirements related to IT investments made by all projects, regardless of type.

3.1.e Program management and project management are inextricably linked and the relationship between the two levels of management is critical to achieving mission success. Project management is different, however, from program management when it comes to timing and composition. The Project Manager works in concert with the

Program Manager, but focuses on the day-to-day execution of the project by industrial contractors, universities, NASA personnel, and other agencies, foreign and domestic. There is also considerable breadth needed to address the safety, cost, schedule, technical performance, team building, human resource, and institutional issues associated with managing a project. The Project Manager should be knowledgeable in all these areas and utilize the experts from line or functional organizations to assist in project formulation and implementation.

3.2 Project Formulation

3.2.a Working through a program office, a MDAA (or MSOD) will usually provide a small amount of discretionary resources for pre-formulation activities (i.e., activities before a project formally enters formulation). These pre-formulation activities involve mission analysis, advanced concept studies, and analyses of alternatives that should be performed before a specific project concept emerges. These trade studies are not considered part of formal project planning since there is no certainty that a specific project proposal will emerge. In programs that use an Announcement of Opportunity (AO) process, program resources are invested (following Step 1 selections) to bring certain mission concepts to a state in which their science content, cost, schedule, technical performance, project implementation strategies, safety and mission assurance implementation strategies, and management approach can be better judged.²³

3.2.b The MDAA (or MSOD) has the authority to initiate a project and begin formulation activities. To effect a project's official entry into formulation, the Program Manager prepares a draft project FAD or equivalent (such as a Program Plan section, MDAA letter selecting a specific AO proposal, or a Program Directive that is used in the Space Station and Shuttle Programs). The draft project FAD is forwarded to the MDAA (or MSOD) for final signature. Once the MDAA (or MSOD) signs the project FAD, a project formally enters formulation. In a new program, formulation of the first project can only begin after the program FAD has been signed and a Program Manager is formally selected by the MDAA (or MSOD).

3.2.c Once selected, the Project Manager is responsible for the evolution of the project concept and ultimate mission success. If requested by the Mission Directorate, Mission Support Office, or Program Manager, the Project Manager assists in revising the PCA.

3.2.d NASA places a good deal of emphasis on project formulation because adequate preparation of project concepts and plans is vital to success. During formulation, the project establishes the success criteria, explores the full range of implementation options, defines an affordable project concept to meet mission objectives specified in the Program Plan, and develops and documents the Project Plan. A key part of the Project Plan describes the Project Baseline, against which the project will be measured. Formulation is an iterative set of activities²⁴ rather than discrete linear steps. Formulation continues with interactive execution of its activities, normally concurrently, until formulation output products have matured and are acceptable to the Program Manager and the MDAA (or MSOD).

3.2.e During project formulation, the Project Manager²⁵ with the project team performs the following activities:

- a. Project planning.
- b. Cost estimation.
- c. Systems engineering.
- d. Independent technical authority.
- e. Project assessment and control.

²³ From the point-of-view of the selected AO-driven project, the winning team is clearly doing formal project formulation (putting together a detailed WBS, schedules, cost estimates, implementation plans, etc.) during the preparation of the Step 2 proposal. From the point-of-view of the program, no specific project has been chosen, so project Level 1 requirements are unknown, costs can encompass a wide range, and a FAD cannot be executed. Consequently, formal project formulation cannot begin. This document recognizes the existence of both views.

²⁴ Activities include flowing down agreed-to success criteria to the system/subsystem level; establishing the internal management control functions that will be used throughout the life of the project; assessing the technology requirements and developing the plans for achieving them; identifying options for partnering and commercialization; performing life-cycle cost (LCC) and mission effectiveness analyses for concepts deemed to have a high degree of technical and operational feasibility; and identifying margins and reserves consistent with project risk.

²⁵ For single project programs, the term Project Manager is usually taken to mean Program/Project Manager.

3.2.1 Project Planning

3.2.1.1 Purpose: This activity develops the project's objectives, requirements, success criteria and concomitant

implementation approaches and technology strategy, establishes the Project Plan, and creates project control structures such as the Work Breakdown Structure (WBS) and Integrated Master Schedule (IMS).

3.2.1.2 Requirements: The Project Manager and the project team shall:

3.2.1.2.a Prepare the Project Plan.

1. At a minimum, the Project Plan shall contain all elements of the template provided in Appendix D. If the Project Manager chooses to write separate plans for some elements of the template, then the Project Plan shall summarize the salient points of the separate plans.
2. Sections of the Project Plan that are replaced by alternative approaches through an approved waiver or deviation shall be clearly identified in the Project Plan.
3. The Project Manager shall have the initial version of the Project Plan completed and ready for review by the Program Manager within the relevant milestone in the Appendix G.
4. The Project Manager shall secure approval of the Project Plan within the relevant milestone as identified in Appendix G. As a minimum, the cognizant Center Director and the Program Manager shall sign the Project Plan.
5. The Project Manager shall evaluate lessons learned from existing and previously executed projects to identify applicable lessons for use in project planning and execution.

3.2.1.2.b Define a Work Breakdown Structure (WBS).

1. The WBS for the project shall encompass all the work required in the project, including both in-house and contractor efforts, over the project life cycle.
2. The WBS for the project shall be based on the appropriate product line template.
3. The WBS shall have a companion WBS dictionary that narratively describes the overall structure and content of each individual element of the WBS, and a WBS index linked to reference individual elements to the dictionary.

3.2.1.2.c Prepare a project Integrated Master Schedule (IMS) as part of the Project Baseline.

1. The project IMS shall show all tasks necessary to accomplish the total scope of work derived from authorizing documents (e.g., FAD, PCA, Program Plan, Contract) and defined in the approved project WBS.
 - i. Activity durations shall identify the realistic number of work periods required to accomplish each activity in the IMS.
 - ii. Resource requirements, capacity, and availability shall be considered.
 - iii. Schedule reserve, based on risks and historical norms, shall be clearly identified.
1. The project IMS shall show all critical project milestones, logical relationships (interdependencies) for all tasks and milestones, and include critical paths, when required, based on both project category and product line type. (See product line chapters).
2. The project IMS shall have traceability to both lower-level detailed schedules and higher-level management summary schedules controlled by the approval authority (e.g., Program Manager, MDAA).

3.2.1.2.d Create a team structure designed to assure mission success.

1. The Project Manager shall develop a team organization compatible with the WBS and the implementation strategies selected for the project. The project's organizational structure shall be documented in the Project Plan, Part 1, Project Management.
2. Project teams can be composed of civil service personnel, contractors, academia, partners, and customers. It is important that project teams have full and open communication. Clear lines of authority and communication must be demonstrated in the project organization chart. Therefore:
 - i. The Project Manager shall develop a project Communications Plan so as to foster effective (upward and downward) communication of critical management, technical, risk, and safety information.
 - ii. The Communications Plan shall specifically define the relationships among various project elements, and unambiguously identify responsibilities for problem reporting and subsequent decision making, during normal and contingency events.
 - iii. The Communications Plan shall define relationships and interactions with all stakeholders, team members, and supporting organizations.

- iv. The Project Manager shall develop a plan to meet the program requirements for a closed loop problem tracking process, described in paragraph 2.2.2.e.
3. The balance of required skills, experience, and the size of the team will likely change through the project life cycle. Therefore, the Project Manager shall develop staffing plans consistent with the needs of the project over its life cycle, staff with personnel with the appropriate skills, abilities, and experience, and provide integrated team training to successfully execute the project.
4. The Project Manager shall negotiate required resources with applicable service pool managers.
5. In their supervisory capacity, Project Managers shall provide for the individual development of personnel that report directly to them. In addition, Project Managers should collaborate with line managers on the individual development needs of other members of the team. Project Managers should identify meritorious performance and create a strategy for using the NASA Awards and Recognition program to acknowledge successful, high-performing individuals and teams. Project Managers should take quick action to remedy unsatisfactory performance, whether through provision of additional guidance or training or, if necessary, changes in personnel.

3.2.1.2.e **Examine and manage requirements for advanced technology.**

1. The Project Manager shall analyze technology requirements for feasibility, availability, technology readiness, and opportunities for leveraging ongoing research. Specifically:
 - i. The Project Manager shall evaluate sources of technology from other NASA Centers. One resource for accomplishing this is the NASA Technology Inventory Database at <http://inventory.gsfc.nasa.gov>.
 - ii. The Project Manager shall also identify commercial, academic, and other government agency sources of technology.
 - iii. Full cost assessments and risk assessments shall be performed to identify preferred sources of technology.
2. The Project Manager shall develop an integrated technology strategy to enable the project to meet its mission objectives. This strategy shall be documented in the Project Plan, Part 3, Technology Strategy:
 - i. The Technology Plan shall describe how the project will remove remaining technology gaps, including maturation, validation, and insertion plans, quantifiable milestones, decision gates, and resources required.
 - ii. Sources of technology shall be clearly identified in the Technology Plan.
 - iii. Distribution restrictions on the software, hardware, or data shall be clearly identified in the Technology Plan.
3. The Project Manager shall work with Center legal and commercialization personnel to establish how project-developed intellectual property (technologies, discoveries, innovations, tools, processes, or software) can be licensed or appropriately transferred to U.S. industry in other ways.
4. The Project Manager shall ensure that all planned technology exchanges, contracts, and partnership agreements comply with all laws and regulations regarding export control and the transfer of sensitive and proprietary information.

3.2.1.2.f **Analyze project infrastructure needs.**

1. Working with the real property and industrial property offices, the Project Manager shall ensure that a comprehensive analysis of project infrastructure (real property/facilities, aircraft, personal property, and information technology IT) needs is performed. This analysis should include infrastructure required for: staff office space, test (including ground and flight facilities) and integration functions, research facilities, data systems, logistics and maintenance facilities, aircraft, and personal property and equipment.
2. The Project Manager, in coordination with the cognizant Center functional office, shall assess existing Agency wide capabilities to meet infrastructure needs, and also assess whether facilities in other Government agencies, industry, academia, and international organizations can be utilized to reduce project LCC and risk. The Project Manager should work with the Program Manager, the MDAA, OCE, CIO, the Office of Infrastructure, Management, and Headquarters Operations, and other Headquarters offices to identify means of meeting infrastructure requirements through synergy with other programs and projects, thus avoiding costly duplication of supporting infrastructure.
3. A business case justification shall be performed for any proposed acquisition or major modification of infrastructure (e.g., facilities, IT).
 - i. The business case shall include full life cycle cost (including operations, sustainment, and disposal), benefit estimates, alternatives and sensitivity analyses, and risk assessments. (For more information on full cost and

practices, see Volume 7 of the NASA Financial Management Requirements.)

- ii. The business case shall be approved by the cognizant MDAA and by the cognizant NASA Headquarters functional office, or their designee(s).
4. First in coordination with the cognizant Center functional office, and then with the Headquarters Office of Infrastructure, Management, and Headquarters Operations, and/or the CIO, as appropriate, the Project Manager shall develop plans for any necessary upgrades or new developments, including those needed for environmental compliance (see paragraph 3.2.1.2j), and then document them in the Project Plan, Part 2, *Resources*.
5. The Project Manager shall comply with the provisions of NPD 7900.4 and NPR 7900.3, *Aircraft Management Operations*, before entering into agreements to procure or operate aircraft that might be necessary to the success of the project. The Project Manager shall directly coordinate with Center Chief of Flight Operations or the Headquarters Aircraft Management Office during the planning stage.
6. The Project Manager shall work with the respective offices at NASA Headquarters and Centers to assure that requisite spectrum allocations and airspace access are available and, if not, to obtain the necessary approval and permits.
7. The Project Manager shall comply with the provisions of current space transportation laws and policies, and NPD 8610.7, *Launch Services Risk Mitigation Policy for NASA-Owned or NASA-Sponsored Payloads*, and NPD 8610.12, *Office of Space Operations (OSO) Space Transportation Services for NASA and NASA-Sponsored Payloads*, involving launch assignment and acquisition before entering into agreements to procure launch services or launch vehicles. The Project Manager shall coordinate with the Space Operations Mission Directorate (SOMD) during planning and formulation for any project requiring launch.

3.2.1.2.g **Manage agreements.**

1. Any use of interagency, industry, academic, and/or international cooperation agreements needs to be addressed early in project formulation. When these agreements are considered for a project, the Project Manager shall work with the appropriate Headquarters offices and, where necessary, have the agreements approved by them. All activities and documentation should be consistent with policy guidelines and with program, Mission Directorate (or Mission Support Office), and Agency-level agreements.
2. All agreements, memoranda of understanding, barter, in-kind contributions, and other arrangements for collaborative and/or cooperative relationships shall be identified in the Project Plan, Part 3, *Cooperation and Commercialization*, and the Project Manager shall maintain signed copies of all such agreements.

3.2.1.2.h **Complete an Acquisition Plan.**

1. The Project Manager shall develop an integrated acquisition strategy that enables the project to meet its mission objectives, provides best value to NASA, and complies with the FAR and the NASA FAR Supplement. The Project Manager shall ensure that applicable laws, regulations, requirements, and standards are flowed down from NASA to the prime and sub-contractors. This strategy shall be documented in the Project Plan, Part 2, *Acquisition Management*.
 - i. The Acquisition Plan shall identify all major proposed acquisitions in relation to the project WBS.
 - ii. The Acquisition Plan shall consider the utilization of NASA in-house capabilities and the maintenance of NASA's core competencies when making make or buy decisions.
 - iii. The Acquisition Plan shall identify the project's approach to creating contractor incentives that strengthen safety and mission assurance.
 - iv. The Acquisition Plan shall identify significant (\$1 million or more) equipment requirements expected to be acquired or fabricated by contractors in support of the project objectives.
2. If systems contain software, the Project Manager shall ensure that software developed internally within NASA or acquired complies with NPR 7150.2, *NASA Software Engineering Requirements*, and NASA Standard 8739.8, *Software Assurance Standard*.
3. The Acquisition Plan shall establish a continuous Risk-Based Acquisition Management (RBAM) process:
 - i. The project acquisition planning team shall obtain input from Center personnel responsible for safety and mission assurance, health, environmental protection, information technology, export control, and security. The goal of this involvement is to ensure that the acquisition is structured to address appropriately the concerns of these disciplines as they relate to the requirement. (See NFS 1807.104.)
 - ii. During the solicitation process, any exchanges with industry prior to receipt of offers should include requests for any perceived safety, occupational health, security (including information technology), environmental,

export control, and/or other programmatic risk issues associated with performance of the work. Similarly, when technical proposals are required as part of requests for proposals for supplies or services, offerors shall be instructed to identify and discuss risk factors and their approach for managing those risk factors (see NFS 1815.201 and NFS 1815.203-72). Where the solicitation requires submission of a Safety and Health Plan (see NFS 1823.7001(c)), safety and health shall be a consideration in the evaluation process (also see NFS 1815.305).

- iii. Quality assurance surveillance plans shall be prepared with the statement of work for all performance-based contracts and, as necessary, for other contracts. The Project Manager shall follow NPR 8735.2, *Management of Government Safety and Mission Assurance Surveillance Functions for NASA Contracts*.
 - iv. Working with SMA, the Project Manager shall ensure that the plans reflect NASA's surveillance approach relative to the perceived programmatic risk. The plans are general at the outset, but after contract award, the Contracting Officer shall ensure that the plans are revised to reflect the risks associated with the successful proposal (see NFS 1846.401 and Procurement Information Circular 02-17).
4. The Acquisition Plan shall be reviewed and approved by the Program Manager prior to initiating any major procurement actions as established in Section 3.2.4.

3.2.1.2.i **Complete a Safety and Mission Success Plan.**

1. The Project Manager shall complete a Safety and Mission Success Plan and ensure close integration with the appropriate Safety and Mission Assurance (SMA) organization. The resulting plan can be incorporated into the Project Plan, Part 3, *Safety and Mission Assurance*.
2. The Project Manager shall perform activities to provide for the early identification, analysis, reduction, and/or elimination of hazards that might cause the following:
 - i. Loss of life or injury/illness to personnel;
 - ii. Damage to or loss of equipment or property (including software);
 - iii. Unexpected or collateral damage as a result of test;
 - iv. Failure of mission;
 - v. Loss of system availability; and/or
 - vi. Damage to the environment.
3. Project Managers shall establish safety and mission success activities as a part of the continuous risk management process early in the project formulation process. Specifically, the Project Manager shall:
 - i. Incorporate health and safety principles in all planning.
 - ii. Perform formal assessment and documentation of each hazard.
 - iii. Control each hazard in accordance with the reduction protocol in NPR 8715.3, *NASA Safety Manual*.
 - iv. Perform a safety assessment or readiness for flight or other operations, explicitly noting any exceptions arising from safety issues and concerns.
 - v. Utilize a quality management system in compliance with NPD 1280.1, *NASA Management Systems*, and with appropriate supplier assessment and surveillance.
 - vi. Provide a reliability, maintainability, and parts assurance program appropriate to the needs of the project.
4. Each project that uses radioactive materials must have an internal NASA process in place for effective intra-Agency and interagency coordination in obtaining launch approval. Therefore:
 - i. Each project shall ensure that system designs that use radioactive materials reduce public and worker exposure to radiation and radioactive materials to levels that are as low as reasonably achievable.
 - ii. Radiological contingency plans, commensurate with the potential health risk to the public, shall be developed for missions carrying radioactive materials in accordance with NPD 1820.1, *NASA Environmental Health Program*, and NPR 8715.3, *NASA Safety Manual*.
 - iii. Each project proposing to launch radioactive materials shall fully adhere to the NASA and Executive branch interagency coordination processes for nuclear launch safety approval in accordance with NPD 1820.1, *NASA Environmental Health Program*, and NPR 8715.3, *NASA Safety Manual*.
 - iv. The Project Manager shall support the NASA Headquarters Office of Safety and Mission Assurance (OSMA) and the Office of Security and Program Protection in obtaining nuclear launch safety approval.

3.2.1.2.j Complete the Education and Public Outreach Plan. The Project Manager shall develop a plan that document linkages between science, engineering, technology, and mathematics (STEM), and the unique project content. Specifically, the plan shall incorporate elements that:

1. Demonstrate a compelling benefit to the public.
2. Show how each project demonstrates contributions to developing a pipeline promoting STEM careers and/or cultivating a workforce in science and technology.
3. Are designed to respond to a need identified by the education community, a customer, or a customer group (customer focus).
4. Demonstrate the connection to NASA missions and other activities that inspire and motivate the Nation's students and teachers, to educate the public, and to advance scientific and technological capabilities of the Nation.

3.2.1.2.k Complete the Environmental Management Plan.

1. With the support of the cognizant Environmental Management Office (EMO), and in accordance with NPR 8580.1, *Implementing the National Environmental Policy Act and Executive Order 12114*, the Project Manager shall complete the Environmental Management Plan and incorporate it into the Project Plan, Part 3, *Environmental Management*.
 - i. The development of the Environmental Management Plan shall be integrated with the installation Environmental Management System so as to ensure appropriate approvals, permits, and consultations are made, and mission delay impacts are avoided or minimized.
 - ii. The Project Manager shall integrate public, intergovernmental, and interagency involvement with the Education and Public Outreach Plan.
2. Environmental planning needs to be integrated into project planning efforts early in formulation, as environmental protection compliance processes can be lengthy. These efforts are accomplished with the support of the cognizant EMO. Specifically:
 - i. The Project Manager shall support the Mission Directorate (or Mission Support Office) to ensure the completion of the NEPA process prior to taking any action which would either (1) have an adverse environmental impact; or (2) limit the choice of reasonable alternatives. In all cases, the Project Manager shall ensure the NEPA process, as explained in NPR 8580.1, *Implementing the NEPA and Executive Order 12114*, is completed prior to project implementation. The Project Manager should allow 6 to 18 months to complete the required NEPA documentation.
 - ii. The project schedule shall include specific milestones for the completion of other documentation required by nuclear launch safety, and other pertinent NASA regulations, environmental statutes and regulations, and Executive Orders.
 - iii. This documentation shall include an orbital debris assessment, if applicable.
 - iv. The Project Manager shall, with the EMO, ensure that all required permits, waivers, documents, approvals or concurrences are obtained to ensure compliance with all applicable Federal, State, Tribal government, and local environmental regulations.
3. The Project Manager shall comply with the applicable provisions of directives implementing NASA's planetary protection policy in NPD 8020.7, *Biological Contamination Control for Outbound and inbound Planetary Spacecraft*, and NPR 8020.12, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*.

3.2.1.2.l Ensure the security of personnel and physical resources under the control of the project.

1. The Project Manager shall work with the Chief of Center Security to identify and control threats to personnel, monitor the level of security-cleared personnel, and employ access control devices and other safeguards.
2. The Project Manager shall employ the recommendations of the Chiefs of Center Security that address physical security and loss-prevention measures within program and project facilities.
3. The Project Manager shall ensure that emergency response, mitigation, and recovery plans have been established for the project, in accordance with NPD 8710.1, *Emergency Preparedness Program*. These plans should be coordinated with the local Emergency Preparedness Office.
4. Each project shall complete preparations and ensure that response capabilities (to include restoration of program-unique resources and capabilities) are available when needed.
5. Each project shall ensure that contingency plans are in place to properly secure a mishap site, impound evidence, and provide necessary notification within the program and to designated Agency notification

contacts.

3.2.1.2.m **Provide for information technology security.**

1. The Project Manager shall take actions (appropriate to the level of sensitivity) to protect the integrity, availability, and confidentiality of project information systems, software applications, data, and information generated within their projects. This includes classified or sensitive information, export-controlled information, industry proprietary data, command, control and communications (C3) information and systems, websites, applications, and information and systems that support NASA's daily business activities (e.g., e-mail management reporting).
2. Project technical requirements shall include information technology security requirements, in accordance with NPR 1620.1, Security Procedures and Guidelines, NPR 2810.1, *Security of Information Technology*, and NASA Information Technology Requirements (NITR). Specifically, the Project Manager shall:
 - i. Conduct risk assessments, determine and implement risk-mitigating technologies or procedures, and manage residual accepted risks.
 - ii. Coordinate project security measures with established Center and Headquarters Boards governing NASA-wide infrastructure security measures.
 - iii. Address specific requirements for security of C³ systems and those systems containing or processing export controlled, proprietary, classified or other sensitive information.
 - iv. Address requirements for affording or limiting access by citizens of foreign countries involved in the project.

3.2.1.2.n **Provide for export control and foreign involvement.**

1. The Project Manager shall comply with the requirements of NPR 2190.1, NASA Export Control Program.
2. All NASA international agreements contain a clause on transfers of controlled hardware, software technology, and data both from NASA to foreign partners and from foreign partners to NASA. The Project Manager shall comply with the clause when transfers are made from NASA to a partner or a contractor of a foreign country.
3. The Project Manager shall transfer only technical data, hardware, and software necessary to fulfill NASA responsibilities under international agreements. Specifically:
 - i. If foreign contracts are anticipated, the Project Manager shall assure that there is appropriate Headquarters review when required, and that such contracts are prepared with appropriate export control provisions.
 - ii. Applicable contracts with U.S. industry that support an international project shall also include appropriate provisions related to export control requirements.
4. Export control requirements and milestones shall be included in project plans.
5. When foreign nationals are involved, the Project Manager shall plan for internal technology transfer controls.
6. The Project Manager shall identify export license requirements and shall obtain any required export licenses prior to exporting.
7. As applicable, the Project Manager shall instruct contractors and partners of NASA obligations under international agreements, and of their responsibility for obtaining proper authority for any contractor and partner exports.
8. The Project Manager shall advise foreign partners of the sensitive nature of export controlled hardware, software, and data prior to transfer.

3.2.2 **Cost Estimation**

3.2.2.1 Purpose: This activity develops credible cost estimates to support a variety of systems engineering trade studies, affordability analyses, strategic planning, capital investment decision making, and budget preparation. It also provides information for independent assessment, as may be required. Good cost estimation is a critical capability needed to ensure the credibility of the project's resource and financial decision-making, and in the larger view, of NASA's financial management system. Cost estimating should be consistent with the NASA Cost Estimating Handbook.

3.2.2.2 Requirements: The Project Manager and the project team shall:

3.2.2.2.a **Develop an initial Life Cycle Cost Estimate (LCCE).**

1. The Project Manager shall develop an initial LCCE consistent with the project WBS, schedule, and

performance parameters to form the project estimate (to be included in the initial Project Plan, Part 2, Resources.)

- i. All cost and workforce estimates shall be summarized according to the NASA standard product line WBS and time phased by Government Fiscal Year (GFY).
 - ii. The project estimate shall always use the latest available full cost accounting initiative guidance and practices.
2. The project estimate shall include reserves, along with the level of confidence provided by the reserves.
 3. (3) Upon completion of the initial LCCE, the Project Manager shall provide it to the Program Manager.

3.2.2.2.b Prior to the NAR, update the project estimate.

1. The Project Manager shall ensure that all elements of the project LCCE are internally consistent and have been updated in time for the NAR (at which time it is designated the NAR estimate).
2. In the event that the (Category I and II) project LCCE and ICE do not agree and cannot be reconciled, the OCFO Cost Analysis Division will provide a recommended cost position to the MDAA (or MSOD), Chief Financial Officer, and Chief Engineer, who together will make a recommendation to the Agency or Mission Directorate PMC. The Project Manager shall defer to their decision.

3.2.3 Systems Engineering

3.2.3.1 Purpose: The purpose of systems engineering is to ensure that the project accomplishes its goals in the most technically robust and cost-effective way possible. Systems engineering provides the integrating technical processes to define, develop, produce and operate the project's systems. As such, the processes involved in systems engineering span the project life cycle and the total technical effort. During formulation, the focus of systems engineering is on planning the systems engineering effort, obtaining and validating a set of system requirements, performing systems analysis to ensure that effective choices are made, defining the preferred system solution through a preliminary design, and planning system verifications and validations. During formulation, these activities lead to the project's NAR Baseline for which implementation approval is sought. (See Figure 3-1.)

3.2.3.2 Overall the flow of the detailed systems engineering processes described below is iterative with any one phase of the system/product lifecycle and is recursive at lower and lower levels of the system structure. Any or all of the processes may need to be repeatedly used in the orderly progression of the project baseline. As an example of the iterative nature, during the course of trade studies, specific requirements, interfaces, or design solutions may be identified as non-optimal and changed to increase system-wide performance, achieve cost savings, or meet scheduling deadlines. As an example of the recursive nature, requirements definition occurs at the system level and also at the subsystem and component levels. Even though it occurs at different times in the system/product lifecycle, the same process is applied.

3.2.3.3 Requirements: The Project Manager and the project team shall:

3.2.3.3.a Plan systems engineering tasks.

1. The Project Manager shall establish the project's overall systems engineering scope and approach, and document it in the Project Plan, Part 3, *Systems Engineering*.
 - i. The Systems Engineering Plan shall comply with an Agency-approved systems engineering standard.
 - ii. The Systems Engineering Plan shall describe how the standard's systems engineering processes will be instantiated by the project, including metrics, and shall identify any deviations and waivers from the standard.
2. The Project Manager shall identify and plan a series of cost-performance trade studies.²⁶
 - i. These trade studies shall, as a minimum, consider safety, performance, life cycle costs, project risks, technology alternatives, schedule, environmental concerns, operations and logistics, and infrastructure issues.
 - ii. In performing these trade studies, the Project Manager shall evaluate the advantages and risks of securing elements of the project from outside sources including partnerships and co-ventures with other government agencies, academia, industry, and foreign organizations.
3. The Project Manager shall plan software engineering tasks per NPR 7150.2, *Software Engineering Requirements* and NASA Standard 8739.8, *Software Assurance Standard*.

3.2.3.3.b **Define, validate, and manage project requirements.** The Project Manager and project team shall flow down program requirements to define a validated set of high-level project requirements prior to entering

implementation. 4/

26 The terms, trade studies, trades, tradeoff analyses, and analysis of alternatives are often used interchangeably, even though the scope of such activities may vary widely.

27 AO-driven projects in the Discovery Program, for example, generate Level 1 requirements from the Step 2 proposal's Concept Study Report, rather than the Program Plan. The requirements are then documented as an appendix to the Program Plan. .

3.2.3.3.c Perform system analyses. The Project Manager and project team shall complete planned cost-performance trades such as Analysis of Alternatives (AoA) studies, Cost as An Independent Variable (CAIV) assessments, mission success probability assessment, and other systems analyses. (Reference L.2.a(8) provides useful detailed information on planning and conducting a formal AoA.)

1. Early in formulation, and in cooperation with the customer, the Project Manager shall define key performance parameters (KPPs) for the project that are selected on the basis of their close relationship with mission success criteria. These KPPs should appear in trade studies as measures of effectiveness and/or measures of performance.
2. As a result of these studies and analyses, but prior to the end of formulation, the Project Manager shall specify quantitative values (a goal value and a threshold value) for each KPP, which will then be incorporated into the Project Baseline (along with the related mission success criteria, schedule, and LCCE) and which will be used to evaluate project performance. For each KPP, the goal is the performance level that the project team is striving for, and the threshold is the minimum performance level that the MDAA (or MSOD) and Program Manager agree is acceptable for the system-of-interest or end item deliverable.
3. As a result of these studies and analyses, the Project Manager shall also establish a close link between each KPP and project technical performance requirements.
4. The Project Manager shall provide the final quantitative values of each KPP to the independent assessment (IA) organization as part of the NAR Baseline.

3.2.3.3.d Define a preferred system design. The Project Manager and project team shall collect and allocate project requirements into an implementable architecture. This activity typically leads to a preliminary design of the system(s) to be developed.

3.2.3.3.e Plan verification and validation efforts. The Project Manager and the project team shall complete the Verification and Validation (V&V) Plan and incorporate it into the Project Plan, Part 3, Test and Verification.

1. (1) The V&V Plan shall clearly identify the approach to the verification of each requirement.
2. (2) The V&V Plan shall include software/hardware integration and appropriate independent verification and validation of software.
3. (3) The V&V Plan shall clearly identify the approach to system validation.

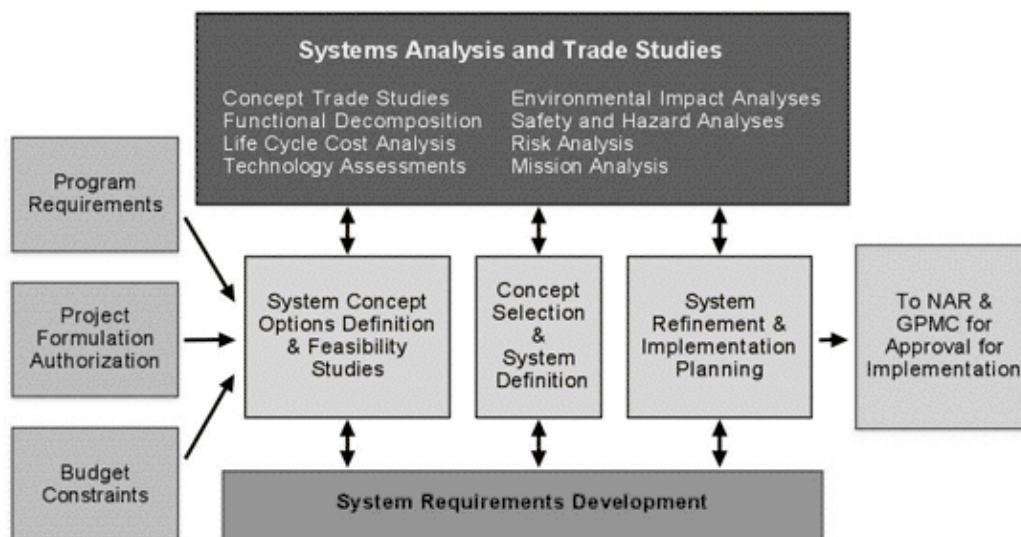


Figure 3-1. Systems Analysis and Trade Study Activities During Formulation

3.2.4 Independent Technical Authority

3.2.4.1 Purpose: The purpose of ITA is to establish sound technical requirements and decisions for safe and reliable system operations. During formulation, ITA establishes technical requirements as part of the project's planned technical approach, once the high-level requirements have been defined by the Mission Directorate (or Mission Support Office).

3.2.4.2 The NASA Chief Engineer has established ITA through a system of Technical Warrant Holders (TWHs), who are funded independently of programs and projects. The TWHs are also administratively in a separate management and reporting chain from the program and project. Ideally, the TWH is organic with the project and may also serve as the lead system engineer for the project (or project chief engineer). Once the high-level requirements have been defined by the Mission Directorate (or Mission Support Office), the TWH, with support from the Project Manager and project team, establishes and maintains the subordinate technical requirements. For requirements associated with safe and reliable operations involving human safety, the TWH is the final authority. For requirements that do not affect safe and reliable operations involving human safety, the Project Manager is the final authority with input from the Technical Warrant Holders. When unresolved issues exist between the Project Manager and the TWH, the Project Manager and the TWH will each raise the issue up their respective reporting chains for adjudication.

3.2.4.3 Requirements: During formulation:

3.2.4.3.a Early in project formulation, the Project Manager, in consultation with the MDAA (or MSOD), shall recommend a Technical Warrant Holder. The NASA Chief Engineer selects the Technical Warrant Holder.

3.2.4.3.b Once the high-level requirements have been defined by the Mission Directorate (or Mission Support Office), the Project Manager shall support the TWH in the establishment and maintenance of the subordinate technical requirements.

- i. (i) The Project Manager shall defer to the TWH in determining which standards and requirements affect safe and reliable operations involving human safety.
- ii. (ii) The Project Manager shall only accept variances regarding technical standards and requirements affecting safe and reliable operations involving human safety when approved by the TWH. This does not preclude the Project Manager from requiring more extensive investigation.

3.2.4.3.c The Project Manager shall communicate unresolved conflicts with the TWH to the Program Manager, and then to the appropriate MDAA (or MSOD) if required. Likewise, the TWH reports unresolved conflicts with the Program/Project Manager to the NASA Technical Authority (NASA Chief Engineer).

3.2.5 Project Assessment and Control

3.2.5.1 Purpose: Through the project assessment and control activity, the Project Manager provides direction and exercises control over all aspects of the project. The purpose of this activity is to maintain synchronization between project plans and requirements, and the resources to be allocated to meeting them, using elements of the Project Plan, budgets, schedules, KPPs, and supplier, partner, and customer agreements. This activity provides the Project Manager with accurate feedback and information on the status and conduct of the project against plans, KPPs, technical and operational requirements, risks, schedules, supplier and other agreements, budgets, and other resources.

3.2.5.2 Requirements: The Project Manager and the project team shall:

3.2.5.2.a **Begin to execute the Project Control Plan as early as practical in formulation.**

1. The Project Manager shall review the EVM guidance provided in paragraph 3.4.3.2 to determine the appropriate application of EVM to the project.
2. The Project Manager shall develop a Project Control Plan and incorporate it into the Project Plan, Part 3, *Project Control*.
3. The Project Manager shall ensure that all elements of the Project Control Plan are fully operational prior to the NAR.

3.2.5.2.b **Establish and conduct a continuum of technical and management reviews.**

1. Reviews provide a venue for communication, coordination, and integration of project activities. The Project Manager shall develop a Project Review Plan and incorporate it into the Project Plan, Part 3, *Reviews*.
2. The Project Manager shall conduct the formulation phase internal reviews, as specified in the Project Review Plan, to ascertain the status of the project, and to provide an integrated, independent technical assessment of

the project's technical risk, and its readiness to proceed to the next level of maturation.

3. At each such review, the Project Manager shall synthesize and document engineering and management inputs, issues, and recommendations (e.g., *Review Item Discrepancies*, *Requests for Actions*).
 - i. All such review inputs shall be subsequently analyzed and recommendations/action items tracked and dispositioned.
 - ii. An index of review inputs and recommendations shall be maintained and made available at all subsequent reviews.

3.2.5.2.c Establish and implement configuration management. The Project Manager shall develop a Configuration Management Plan and incorporate it into the Project Plan, Part 3, Configuration Management. 28

28 Various supporting engineering disciplines have specific configuration management policies and procedural requirements that support project-level configuration management. (See NPR 7150.2 for content requirements for software configuration management plans.)

3.2.5.2.d Put in place a comprehensive risk management decision making process.

1. In accordance with NPR 8000.4, *Risk Management Procedures and Guidelines*, the Project Manager shall establish a continuous risk management (CRM) process that identifies risks; analyzes their impact and prioritizes them; develops and carries out plans for risk mitigation or acceptance; tracks risks and the implementation of mitigation plans; supports informed, timely, and effective decisions to control risks and mitigation plans; and assures that risk information is communicated and documented. (The CRM process is shown in Figure 2-1.)
2. The Project Manager and project team shall develop a Risk Management Plan that meets the program requirements for CRM processes as described in paragraph 2.2.2.d and incorporate it into the Project Plan, Part 3, Risk Management.
3. Risk identification shall involve the entire project team to assess all identifiable risks and project constraints up front. If an Independent Assessment (IA) has been performed, the project shall include the risks identified during the assessment as input.
4. Each project shall follow the CRM process steps as shown in Figure 3-2; this process is iterated throughout the project life cycle. Specifically, the Project Manager and the project team shall:
 - i. Identify. Develop the risk statements in terms of condition and consequence(s); capture the context of the risk scenario; e.g., what, when, where, how, and why. Tools such as Failure Modes and Effect Analyses (FMEA), Probabilistic Risk Assessment (PRA), and Fault Tree Analyses (FTA) can be used to identify risks. During engineering product development, risk will be identified and addressed in the final product as part of a risk management plan, in accordance with systems safety engineering practices.
 - ii. Analyze. Evaluate risk probability, impact/severity, and timeframe (when action needs to be taken); classify/group with similar/related risks; and prioritize. Tools such as Probabilistic Risk Assessment (PRA) can be used to analyze risk.
 - iii. Plan. Assign responsibility, determine approach (accept, mitigate, or watch); if risk will be mitigated, define mitigation level (e.g., action item list or more detailed task plan) and goal and include budget estimates.
 - iv. Track. Acquire/update, compile, analyze, and organize risk data; report results; and verify and validate mitigation actions.
 - v. Control. Analyze results, decide how to proceed (replan, close the risk, invoke contingency plans, and continue tracking); execute the control decisions.
 - vi. Communicate and document. Essential risk status is to be communicated on a regular basis to the entire project team, as well as to the GPMC. A system for documentation and tracking of risk decisions will be implemented.

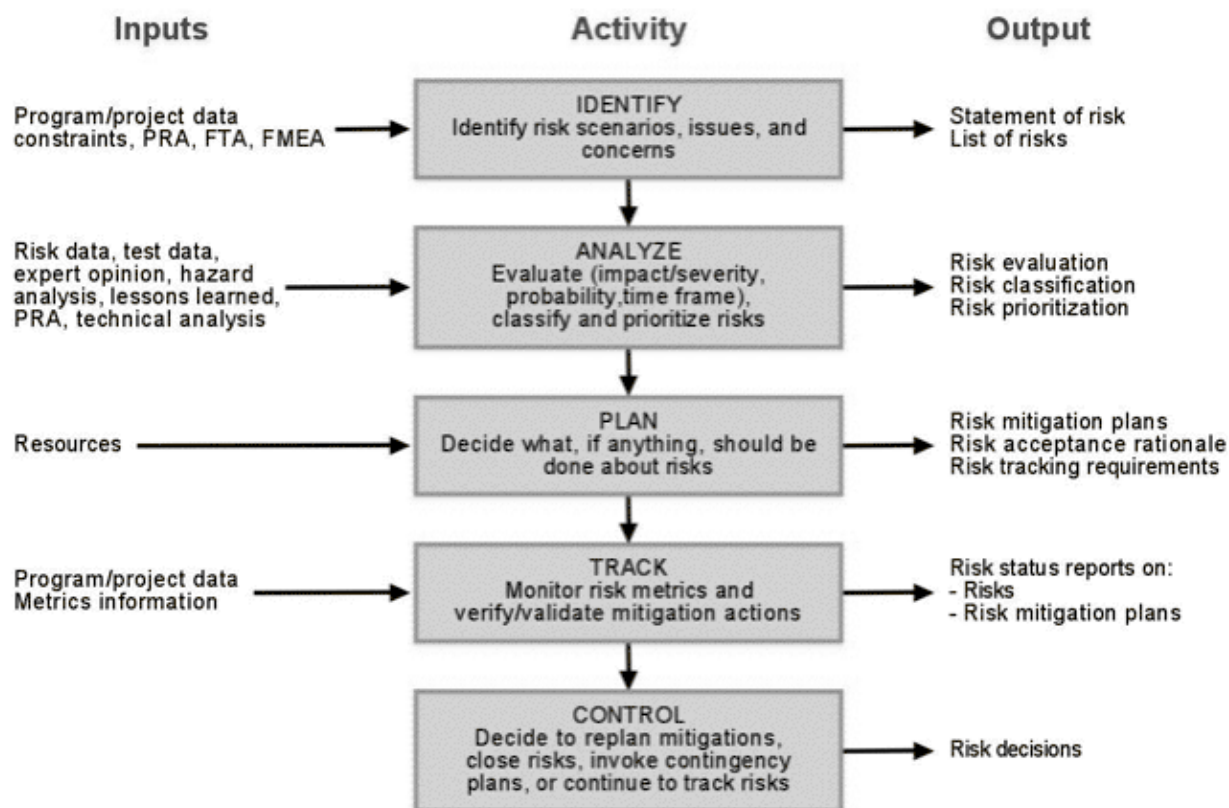


Figure 3-2: The Continuous Risk Management Process Steps

5. The Project Manager shall use the risk management process as a basis for decisions to mitigate cost, schedule, technical, environmental, security, or safety risk. Examples include, but are not limited to, mission success criteria; development schedule; budget limits; launch window and vehicle availability; international partner participation; critical single-source suppliers; security or environmental concerns; human space flight safety issues; "fail ops/fail safe" requirements; facilities and infrastructure limitations; technology readiness; surveillance requirements; and amount and type of testing.
6. For each primary risk, the project shall develop and maintain the following in accordance with the Risk Management Plan and, as appropriate, in the PCA.
 - i. Description of the risk, including primary causes and contributors, actions embedded in the program/project to date to reduce or control it, and information collected for tracking purposes.
 - ii. Identify primary consequences (including effects on safety, project cost, schedule, and performance) should the undesired event occur.
 - iii. Estimate of the probability (qualitative or quantitative) of occurrence together with the uncertainty of the estimate. The probability of occurrence should take into account the effectiveness of any implemented risk mitigation measures.
 - iv. Characterization of the risk as "acceptable" or "unacceptable" with supporting rationale.
7. (7) Characterization of a primary risk as "acceptable" shall be supported by the rationale, with the concurrence of the GPMC, that all reasonable mitigation options (within cost, schedule, and technical constraints) have been instituted. Moreover, the GPMC must concur that, given the risks and their impact on the probability of the project meeting its requirements, the expected value of the project is still sufficient to justify the costs of undertaking it.

3.2.5.2.e Identify project standards and practices.

1. The Project Manager shall document the technical standards and any intended variances from NASA Preferred Standards as identified by the TWH in the Project Plan, Part 3, *Standards and Practices*.
2. The Project Manager shall acquire approvals from the Technical Warrant Holder, and other authorities as

appropriate, before executing any variances from mandatory NASA standards or specifications as established in Section 3.2.4.

3. In accordance with the Standards and Practices section of the Project Plan, the Project Manager shall ensure that designs utilize the International System of Units (SI, metric measurement system), in concurrence with NPD 8010.2, *Use of the SI (Metric) System of Measurement in NASA Programs*.

3.3 Project Approval

3.3.1 Purpose: The project approval process is an ongoing effort by senior NASA management to determine the project's readiness (at key milestones) to proceed with the next project phase.²⁹ To secure project approval, the Project Manager must prepare (or revise) key project management documents (Project Plan, etc.) and submit them to the GPMC at a decision review meeting.

²⁹ For existing projects, re-approval may be required during implementation as a result of proposed changes to the PCA and Project Plan based on budgetary, technical, or institutional considerations.

3.3.2 The term "ongoing" is used in paragraph 3.3.1 because the number of key milestones at which decision reviews are required varies from project to project. The number and focus of decision reviews depends on the project's product line and development strategy. Most projects will have at least one decision review--the NAR--occurring between formulation and implementation. Flight systems and ground support projects will have additional decision reviews that are identified in Chapter 6. Basic and applied research portfolios and real property institutional projects are exempt from the requirements of Section 3.3.

3.3.3 Requirements: In support of GPMC decision review meetings during project approval:

3.3.3.a The Project Manager shall support evaluation by the IA organization in accordance with the project evaluation process. (See Section 3.5.)

3.3.3.b The Project Manager shall prepare a project readiness overview briefing for presentation at the GPMC milestone decision review meeting to include a summary of the project, the status of project documentation and products, concurrence of TWH on technical requirements (including all variances), and significant risks, all appropriate to the level of project maturity.

3.3.3.c The Project Manager shall prepare (and/or submit) the project documents and products described in Table 3-1.

3.3.3.d At that meeting, the IA results and findings, including an ICE for Category I and II projects, will also be presented. The Project Manager shall then follow with a presentation of responses to the IA findings.

3.3.4 When all presentations are concluded, the GPMC convenes an executive session to discuss the material presented and determines whether to recommend approval to the appropriate decision authority. The decision authority for Category I projects is the Deputy Administrator; for Category II projects, the MDAA (or MSOD); and for Category III projects, the Center Director (of the executing Center). A positive recommendation may be unconditional, or conditional on the Project Manager completing assigned action items, some of which address the IA organization findings. A negative recommendation by the GPMC could result in the decision authority either directing the Project Manager to address the deficiencies, or in the authorization of a termination review. If project approval requires a modification to the PCA, the MDAA (or MSOD) is responsible for obtaining PCA approval by the Deputy Administrator. Upon GPMC approval, the project's NAR Baseline is formally established.

Key Management Document or Product	NAR
Project FAD	Yes
PCA (revised as needed)	Final
Project Plan	Final

Table 3-1. Key Project Documents and Product Maturity by Decision Review

3.4 Project Implementation

3.4.1 Project implementation entails continued execution of the Project Plan and all design and development activities leading up to the successful transition-to-use of the product or service that meets the original requirements and customer expectations, followed by operations through final disposition of project assets. Project implementation requires close interaction between the project team and the customer(s).

3.4.2 The Project Manager and project team executes implementation activities in accordance with the controlling documents developed during formulation and the approval process, but during implementation, projects may be impacted by external forces, such as budget modifications, schedule, or requirements changes, and internal situations, such as technology challenges or new requirements. Formulation products may need to be revisited to ensure that the planning is consistent with commitments and resource availability. If necessary, agreements (PCAs, Program and Project Plans) are modified and approved in accordance with the approval process. During project implementation, the Project Manager with the project team performs the following activities:

- a. Project assessment and control.
- b. Customer advocacy.
- c. Systems engineering.
- d. Design, develop, transition-to-use, and operations.
- e. Independent technical authority engagement.
- f. Capture knowledge.

3.4.3 Project Assessment and Control

3.4.3.1 Purpose: Through the project assessment and control activity, the Project Manager provides direction and exercises control over all aspects of the project. The purpose of this activity is to ensure that the project is making progress commensurate with the resources expended. This activity provides the Project Manager with accurate feedback and information on the status and conduct of the project against plans, KPPs, technical and operational requirements, risks, schedules, supplier and other agreements, budgets, and other resources.

3.4.3.2 Requirements: The Project Manager and the project team shall:

3.4.3.2.a **Execute the Project Control Plan.** The intent of this requirement is to maintain close configuration control of requirements, to assess the cost, technical and schedule status of the project relative to the NAR Baseline. Therefore:

1. EVM principles as defined by EIA-748-A ³⁰ shall be applied to all projects (contractor and civil service) exceeding \$20M total project cost. However, the MDAA (or MSOD) can require EVM principles be applied to any project or activity.
2. A fully validated EVM system as defined by EIA-748-A shall be applied to all projects (contractor and civil service) exceeding \$50M total project cost. However, the MDAA (or MSOD) can require a fully validated EVM system be applied to any project or activity.
3. In implementing (1) and (2) above, the Project Manager shall ensure (for all applicable procurements) the appropriate provisions and clauses are included in solicitations and contracts.
4. For projects requiring EVM, the Project Manager shall conduct and complete Integrated Baseline Reviews (IBRs) on projects to ensure the validity of the baseline.

³⁰ These principles are listed here for clarity: (1) plan all work scope for the project to completion; (2) break down the project work scope into finite pieces that can be assigned to a responsible person or organization for control of technical, schedule, and cost objectives; (3) integrate project work scope, schedule, and cost objectives into a performance measurement baseline plan against which accomplishments may be measured and control changes to the baseline; (4) use actual costs incurred and recorded in accomplishing the work performed; (5) objectively assess accomplishments at the work performance level; (6) analyze significant variances from the plan, forecast impacts, and prepare an estimate at completion based on performance to date and work to be performed; and (7) incorporate Earned Value Management into the project's decision-making and review processes.

- i. The IBR shall be accomplished within six months after contract award or after approval of the Project Plan by the MDAA (or MSOD).
- ii. The IBR shall be accomplished within two months after definitization of significant scope changes or after budget realignment.

5. Surveillance of contractor EVM systems is normally delegated to the Defense Contract Management Agency

(DCMA) in accordance with the NASA/DCMA Memorandum of Understanding (MOU) for Earned Value Management System Acceptance/Surveillance and Earned Value Management Project Surveillance. When such surveillance is to be delegated, the Project Manager shall, in coordination with the Contracting Officer, initiate the action for the Contracting Officer to issue a letter of delegation to the responsible DCMA activity. The letter of delegation shall define the specific support, products, services, etc., to be provided by the DCMA. (See FAR Part 42.2.)

6. Expenditures shall be accumulated according to the WBS established for the project and in as near-real time as possible. Consistent with Continuous Cost-Risk Management (see reference L.2.a(1)), in addition to standard WBS-level performance measurement reporting, performance measurement of medium- and high-risk WBS elements identified during life cycle cost estimation shall be provided to the Project Manager through specification in the Cost Performance Report (CPR) Data Requirements Description (DRD) and/or the Project Plan.
7. The full cost of civil service labor shall also be accumulated according to the WBS to permit later integration into full cost accounting and reporting.
8. Use of EVM is optional in contracts with research institutes and in grants of any type. In such cases, when EVM is appropriate to the project but not to such project components, the Project Manager shall include in the Project Plan, Part 3, Control, the strategy for integrating cost and schedule aspects of those project components.

3.4.3.2.b **Manage reserves.**

1. Project Managers have the authority to make decisions, allocate reserves, and modify the implementation path in response to new information. The Project Manager shall closely monitor the application of project reserves.
2. The Project Manager shall treat all program transfers to the project during implementation, other than planned project reserve funds being held by the Program Manager, as augmentations to the Project Baseline. This includes the use of civil service labor above the staffing plan provided by the project. Such transfers may not imply an impending breach, but the Project Manager must follow paragraph 3.4.3.2e.

3.4.3.2.c **Perform continuous risk management.**

1. The Project Manager and project team shall perform the five-step continuous risk management process of Figure 3-2 during implementation.
2. The Project Manager shall ensure that all elements of the Risk Management Plan are followed.
3. The Project Manager shall communicate risk mitigation actions taken, the effectiveness of risk mitigation activities, and residual risks to the Program Manager for QSR briefings.
4. All risks shall be dispositioned before the transition to operations or the equivalent for an advanced technology project.

3.4.3.2.d **Conduct the implementation phase reviews specified in the Project Review Plan.**

1. The Project Manager shall conduct the implementation phase internal reviews, as specified in the Project Review Plan, to ascertain the status of the project and to provide an integrated, independent technical assessment of the project's technical risk and its readiness to proceed to the next level of maturation.
2. For each review, the Project Manager shall synthesize and document engineering and management inputs, issues, and recommendations (e.g., Review Item Discrepancies, Requests for Actions).
 - i. All such review inputs shall be subsequently analyzed, and recommendations/action items tracked and dispositioned.
 - ii. An index of review inputs and recommendations/action items shall be maintained, and made available at all subsequent reviews.

3.4.3.2.e **Provide information and data regarding a breach of the NAR Baseline.**

1. The Project Manager shall monitor project performance and provide trending data to the Program Manager.
 - i. For the cost metric, cost growth shall be measured after project approval using the latest project cost Estimate at Completion (EAC) against the NAR cost baseline (the approved NAR estimate). (Since the NAR estimate contains project reserves, cost growth occurs only when these reserves are exhausted.)
 - ii. For the schedule metric, schedule growth shall be measured after project approval using the latest project

schedule Estimate at Completion (EAC) against the NAR schedule baseline. The schedule baseline shall start from the date of project FAD approval and shall extend through project completion (considered to be end of prime mission for long-lived projects).

- iii. KPP changes shall be measured using the latest project performance against the NAR threshold values.
- 2. The Project Manager shall report to the Program Manager when the results of surveillance reviews conducted by IA organizations indicate that a breach is to be expected.
- 3. When projected cost or schedule performance exceeds the NAR Baseline by ten percent (10%), or a KPP breaches its threshold value, the Project Manager shall report the breach to the Program Manager and the information shall be presented to the GPMC.
- 4. The Project Manager shall coordinate with the Program Manager to provide a proposed continuation or termination plan to the GPMC.

3.4.3.2.f Evaluate and coordinate actions related to changes in project scope, requirements, schedules, funding, or anticipated progress. Changes to the Project Baseline that lead to commensurate changes in the procurement requirements and deliveries shall be quickly communicated in the form of procurement change documentation.

3.4.3.2.g Maintain configuration management.

- 1. The Project Manager shall ensure that baselined project documents are maintained under configuration management.
 - i. The Project Manager shall maintain configuration management on all drawings, design specifications, part selections, and other means of documenting aspects of the design (e.g., close-out photographs).
 - ii. Final versions of design documentation shall reflect the "as-built," "as-delivered," or "as-deployed" configuration of the system/asset.
- 2. The Project Manager shall place all dimensions of the Project Baseline (cost, schedule, and KPPs) under configuration management, retaining the Project Baseline at the time of the NAR (the *NAR Baseline*) as the datum against which changes are measured.

3.4.3.2.h Maintain project team awareness of emergency response plans and procedures. Specifically, the Project Manager shall test those procedures at planned intervals during project implementation.

3.4.3.2.i Protect intellectual property and technology. The Project Manager shall protect contractor proprietary data provided in support of Government analyses and reviews, and maintain required non-disclosure agreements (NDAs).

3.4.4 Customer Advocacy

3.4.4.1 Purpose: The purpose of this activity is to proactively consult and involve customers in the implementation process to ensure customer satisfaction with delivery of quality products and services within budget and schedule commitments. It provides internal implementation process advocacy of customer interests in project decision forums.

3.4.4.2 Requirements: The Project Manager and the project team shall:

3.4.4.2.a Maintain close customer interactions per the Project Plan. Specifically, the Project Manager shall proactively consult and involve customers in implementation activities, especially efforts that impact requirements and KPPs.

3.4.4.2.b Involve customers as an integral part of evaluating progress against commitments.

3.4.5 Systems Engineering

3.4.5.1 Purpose: The purpose of systems engineering is to ensure that the project accomplishes its goals in the most technically robust and cost-effective way possible. Systems engineering provides the integrating technical processes to define, develop, produce and operate the project's systems. As such, the processes involved in systems engineering span the project life cycle and the total technical effort. In implementation, the focus of systems engineering is on transforming the selected design solution into an integrated set of products/services that comply with the baselined system requirements, verifying those requirements, transitioning the end products to use, and validating those products/services.

3.4.5.2 Requirements: The Project Manager and project team shall:

3.4.5.2.a Define, validate, and manage project requirements.

1. Throughout implementation, the Project Manager shall maintain a well-documented hierarchy of validated project requirements.³¹
2. The Project Manager shall ensure that the hierarchy of requirements and the resulting end-item specifications, including those for software, GFE, and operations, are maintained under configuration management, and that modifications to requirements are recorded in a change log as part of overall project configuration management mechanisms.
3. The Project Manager shall evaluate changes in requirements that impact safety, quality, cost, schedule, and performance, and incorporate the impacts as changes to the Project Baseline.

³¹ The project software requirements are developed and documented in compliance with NPR 7150.2.

3.4.5.2.b Manage technical resource margins (e.g., mass, volume, power). The Project Manager shall manage all technical resource margins and apply project-level technical reserves as needed during design maturation.

3.4.5.2.c Implement the closed loop problem tracking process developed during formulation. (See paragraph 3.2.1.2.d(2)(iv).)

3.4.5.2.d Comply with the Standards and Practices section of the Project Plan.

1. The Project Manager shall ensure that standards and practices identified in the Project Plan are implemented.
2. The Project Manager shall acquire approvals from the Technical Warrant Holder, and other authorities as appropriate, before executing any variances from mandatory NASA standards or specifications as established in Section 3.2.4.

3.4.5.2.e Complete verification and validation (V&V) activities.

1. The Project Manager shall implement the V&V strategy outlined in the V&V Plan. The Project Manager and project team should be ready to adjust the plan during implementation to deal with unexpected events and the need for additional verification.
2. The Project Manager shall be responsible for assuring that proper inspection, testing, screening, and/or other verifications have been performed.
 - i. Test plans shall include acceptance criteria.
 - ii. Test data shall be fully documented and maintained to support downstream analyses of project products and services, and of any operational anomalies and mishaps, if needed.
3. Deliverable products/services shall be verified prior to transfer for operations.

3.4.6 Design, Develop, Transition-To-Use, and Operations

3.4.6.1 Purpose: This activity develops the specific project products and services, and establishes the supporting infrastructure for continuing production, training, sustaining engineering, logistics, and operations. For flight systems and ground support projects, the integration of design, development, manufacturing, verification and validation, certification, operations capability development, launch operations and checkout, and in-space operations are major elements of this activity.

3.4.6.2 Requirements: The Project Manager and the project team shall:

3.4.6.2.a Implement the technology strategy.

1. The Project Manager shall closely monitor the readiness of advanced technology developments occurring within the project or being supplied under partnering agreements, as per the technology strategy, for the purpose of exercising alternative technology options before the project's cost and schedule are at risk. Technologies supplied by outside sources should be tracked as high risk deliveries until such time that objective data can confirm that lower risk levels are appropriate.
2. The Project Manager shall ensure that adequate resources are made available to document the design, development, certification, and validation of technologies created under project auspices.
3. The Project Manager shall periodically update the appropriate Center and Headquarters commercialization offices with information relevant to the commercialization of project-developed intellectual property (i.e.,

technologies, discoveries, innovations, tools, processes, or software) by U.S. industry.

3.4.6.2.b **Generate a procurement package for each acquisition action.**

1. The Project Manager shall generate a procurement package that contains a statement of work including performance standards, specifications, documentation deliverables, and other applicable data.
2. In this process, the Project Manager shall use a Draft Request for Proposals (DRFP) as required by NFS 1815.201, Exchanges with Industry Before Receipt of Proposals, to ensure that comments on acquisition requirements (from contractors and other potential providers) are obtained. When a DRFP is not required, the Project Manager should consider a less formal method for obtaining industry comment.

3.4.6.2.c **Develop and execute contracts and non-procurement instruments.**

1. In collaboration with the appropriate Center and/or Headquarters offices, the Project Manager shall develop or select the most appropriate acquisition instrument, per the Acquisition Plan, to satisfy program and project goals.
2. The Project Manager shall assist the Contracting Officer in the solicitation and award of contracts, and in the development of a plan to ensure appropriate surveillance, monitoring, and reporting of activities related to contracts and non-procurement instruments in accordance with Federal law and regulations.
3. If systems being acquired contain software, the Project Manager shall ensure compliance with the software contract requirements in NPR 7150.2, NASA Software Engineering Requirements.

3.4.6.2.d **Closely monitor contractor performance.**

1. The Project Manager shall ensure that adequate contract mechanisms are in place to ensure timely and complete receipt of contractor (or grantee) financial and progress reports throughout the contract life cycle.
2. With the aid of the Contracting Officer (or other cognizant acquisition specialist), the Project Manager shall continually assess the performance of each contractor (or grantee). The Project Manager has a responsibility to ensure that the value of items or services received remains commensurate with the plan for funds expended.
 - i. EVM shall be used as a tool to monitor contractor performance as described in paragraph 3.4.3.2.
 - ii. Records of contractor and grantee performance shall be maintained in accordance with Government, Agency, Mission Directorate, and Center policies to support future source selection activities.
 - iii. The Project Manager and the Contracting Officer shall report the Government's assessment of performance to the contractor (or grantee).
3. In cases where the Defense Contract Management Agency (DCMA) conducts or supports the performance monitoring function, the Project Manager shall ensure that DCMA responds to requests for information in a timely fashion.
4. The Project Manager and the Contracting Officer shall perform surveillance of contractor safety and mission assurance performance in accordance with NPR 8735.2, Management of Government Safety and Mission Assurance Surveillance Functions for NASA Contracts.

3.4.6.2.e Ensure that safety and reliability are an integral part of the product/service design, development, production, and operations. Specifically, where the safety of the public, NASA or contractor personnel is at risk, the Project Manager shall reinforce NASA's first core value, Safety, and emphasize to the project team that safety of the public, NASA flight crews, government and contractor employees, and Agency critical assets is of paramount importance.

3.4.6.2.f **Ensure compliance with property control rules and regulations.**

1. The Project Manager shall ensure that property control rules and regulations are carefully followed. Specifically, the Project Manager shall ensure that:
 - i. Property is safeguarded at all times.
 - ii. Equipment, systems, components, and other elements of hardware and software developed under contract(s) and/or grant(s) are not transported without required documentation being executed.
 - iii. Parts, equipments, and components under NASA control are stored in secure facilities with environmental controls and location tracking appropriate to the value of the property.

4. The Project Manager shall also ensure that NASA personnel follow property control rules and regulations when accessing parts and equipment under property control by contractors.
3. The Project Manager shall ensure that NASA personnel follow Agency guidance in procuring spare parts per NPR 5900.1, NASA Spare Parts Acquisition.

3.4.6.2.g Execute Quality Assurance Plans.

1. (1) The Project Manager shall ensure that government, contractor, and grantee personnel follow design, development, manufacturing, and fabrication quality assurance practices matched to the investment that the project represents.
2. (2) The Project Manager shall ensure the completeness and integrity of Quality Assurance Plans or other documentation developed to measure the quality of products and services delivered by the project.

3.4.6.2.h Transition the system/asset to the end-user for operations.

1. (1) The Project Manager shall establish and maintain an integrated logistics support capability to enable continued operations consistent with the system/asset's intended use.
2. (2) The Project Manager shall ensure that adequate checkout of the system/asset is performed, and that formal acceptance of the delivered item(s) is secured at the appropriate transition point.

3.4.6.2.i As part of sustaining engineering, perform trend analyses.

1. (1) The Project Manager, with the TWH, shall monitor system incidents, problems, and anomalies, as well as system margins to ensure that deployed project systems function as intended.
2. (2) Adverse trends shall be carefully evaluated and alerts shall be issued to the Program Manager, if adverse trends cannot be reversed.
3. (3) The Project Manager shall ensure that project engineering data related to failures, anomalies, evaluations, problems, incidents, and Requests for Action (RFAs) are captured, retained, and made available to the NESC upon request.

3.4.6.2.j Ensure the orderly disposition of the system/asset at the end of its useful life.

1. (1) The Project Manager shall ensure that all requirements are met for archiving, preserving, transferring, and/or disposing of data, information, hardware, and software components.
2. (2) Records shall be maintained that track disposed assets.
3. (3) For assets with retained value, an asset valuation shall be performed prior to final disposition.

3.4.7 Independent Technical Authority

3.4.7.1 Purpose: The purpose of ITA is to establish sound technical requirements and decisions for safe and reliable system operations. During implementation, the ITA maintains project technical standards, requirements, and procedures as established in Section 3.2.4.

3.4.7.2 Requirements: During implementation, the Project Manager and the project team shall:

3.4.7.2.a Include the Technical Warrant Holders (TWHs) as a part of the Project Manager's analysis, evaluation, and technical decision-making processes.

3.4.7.2.b Ensure that variances from technical standards and requirements affecting safe and reliable operations have been approved by the TWH and other authorities as appropriate.

3.4.7.2.c Communicate unresolved conflicts with the TWH to the appropriate MDAA (or MSOD). Likewise, the TWH reports unresolved conflicts with the Program/Project Manager to the NASA Technical Authority (NASA Chief Engineer).

3.4.7.2.d Obtain the technical approval of the cognizant TWH for the guiding technical requirements governing the conduct of risk assessments and analysis.

3.4.8 Capture Knowledge

3.4.8.1 Purpose: The intent of this activity is to accrue knowledge in an organized fashion to improve the performance, and reduce the cost and risk of future programs and projects, and to adhere to Federal and NASA

requirements for records management and retention. Lessons learned are disseminated by the OCE and reflected in modifications to NASA training and technical standards and practices.

3.4.8.2 Requirements: The Project Manager and the project team shall:

3.4.8.2.a Ensure that project engineering and cost data, technical management information, and official project records (collectively called the project library) are captured electronically, retained, secured, disseminated, and managed in accordance with agreements, the Project Plan, and program, Center, and Agency policies.

3.4.8.2.b Provide the OCE with inputs to the Lessons Learned Information System in the form of captured experiences and lessons learned by the project team throughout the project lifecycle, for example, at major milestones.

3.5 Project Evaluation

3.5.1 NASA's leadership places a high value on independent review of programs and projects as an unbiased quality check of the engineering and management efforts.

3.5.2 Purpose: Evaluation provides an independent assessment (IA) of the ability of the project to meet its technical and programmatic commitments. The evaluation process utilizes independent review teams composed of knowledgeable, independent experts from outside the advocacy chain of the project. Evaluation during formulation supports the approval process by providing findings and supporting data needed to decide whether to proceed to implementation. Evaluation during formulation assesses whether a project supports the Agency vision and strategic goals, and whether that project can be successfully conducted within available resources and applicable constraints. Evaluation during implementation assesses whether a project continues to contribute to Agency vision and goals, is being successfully executed according to the Project Plan, and provides findings to enhance the project's technical and programmatic performance.

3.5.3 These evaluations are generally planned to minimize disruptions to the project and avoid unnecessary duplication of review events. In keeping with that policy, NASA will adjust its project evaluations and management accountability hierarchy to accommodate programs that are an evolving system-of-systems. Specifically, when a program uses an evolutionary acquisition approach, reviews of projects under that program by the GPMC will occur at the "spiral level" milestones, and milestone decision meetings for the major program elements (i.e., projects) will be held by the GPMC to coincide with the spiral decision reviews.

3.5.4 Requests for *external* audits and assessments of projects may come from the Congress, the NASA Inspector General, the Government Accountability Office (GAO), advisory groups such as Science Advisory Committees, and other similar sources. When requested, the OCE will coordinate responses to external review requests, work in concert with the MDAA (or MSOD) to disposition such requests, and coordinate the scheduling of such activities with the Project Manager, Program Manager, and GPMC.

3.5.5 Special-purpose independent reviews (e.g., Termination Review) will be conducted when directed by the GPMC, the Mission Directorate, (or the Mission Support Office). Requests for special purpose reviews may come to the GPMC from customers, line organizations, or others. Elements such as the anticipated inability of a project to meet its commitments, an unanticipated change in Agency strategic planning, or an unanticipated change in the NASA budget may initiate such reviews.

3.5.6 Because independent reviews require a significant investment of resources, NASA seeks to minimize the number of these external reviews that the Project Manager and project team must support. For basic and applied research activities, evaluation relies on peer review and this section is not applicable. (See Chapter 4, Section 4.5 for applicable requirements.) Advanced technology development projects have only one GPMC decision review--the NAR. (See Chapter 5, Section 5.5, for applicable requirements). Flight systems and ground support projects will be evaluated at multiple designated GPMC decision reviews and through surveillance conducted after NAR approval on Category I and II projects. (See Chapter 6, Section 6.5 for applicable requirements.)

3.5.7 The general process flow leading to each GPMC project decision review is as follows: The Project Manager schedules project site field review events with the IA organization. During the IA organization site field review, the Project Manager presents a detailed project briefing, which demonstrates the project's readiness to continue. This briefing includes a project cost estimate. At the end of the IA organization site field review, the IA organization provides a preliminary verbal outbrief to the Project Manager. The IA organization prepares an initial briefing and briefs the Project Manager. The Project Manager reviews the initial briefing's findings, facts, and assumptions, and provides a formal response to the IA organization. The IA organization and Project Manager brief the Program Manager, Center management (if applicable), and the Mission Directorate on findings and program responses. The IA organization prepares a final briefing and issues it to the Project Manager and GPMC members. After the final briefing is issued, the Project Manager and IA organization brief the GPMC.

3.5.8 Requirements: To accomplish the project evaluation process, the Project Manager shall:

3.5.8.a Plan project team and schedule resources to support IA for the NAR decision review. For initial planning purposes, the Project Manager should consult Table H-3 in Appendix H. The project's planning schedule may be modified through negotiation with the IA organization.

3.5.8.b Comply with the evaluation Terms of Reference (ToR) or equivalent for all independent reviews.

1. The ToR or equivalent is prepared by the IA organization through negotiation with the Project Manager and Program Manager, MD (or MSO) point-of-contact, or appropriate organization. The ToR is approved by the OCE and the MDAA (or MSOD). The ToR (or equivalent) specifies the details of conducting site field review events, including the schedule, deliverable items and areas of project risk. For IAs performed by IPAO or SMO, if the negotiating parties cannot agree on the ToR scope and content, the OCE shall be the final decision authority.
2. The final schedule shall be documented in the evaluation Terms of Reference (ToR).

3.5.8.c Prepare project briefings and material demonstrating the project's readiness to continue, and present them at the IA organization site field review. These briefings shall include a project cost estimate. The Project Manager should consult Table H-1 in Appendix H for other assessment criteria.

3.5.8.d Review the initial IA organization briefing's findings, facts, and assumptions, and provide a formal response to the IA organization.

3.5.8.e Comply with external requests for evaluation and audit (e.g., Congress, OMB, the NASA Inspector General, GAO, etc.).

3.5.8.f Support any additional independent reviews or technical assessments that may be required during formulation and implementation as directed by the Administrator, GPMC, MDAA, the OCE (including the NESC), or the Office of Safety and Mission Assurance. The Project Manager shall provide formal responses to action items/recommendations from these reviews for closure.

3.5.8.g Ensure that project engineering data related to failures, anomalies, evaluations, problems, incidents, and Requests for Action (RFAs) are captured, retained, and made available to the NESC upon request.

3.5.8.h In cases where a major project milestone (as identified in the Project Plan, Part 2, *Schedules*) slips but may not appear to breach the overall project completion, the Project Manager shall notify the Program Manager and GPMC. In order to understand the consequences of the slip, the GPMC may direct an independent assessment to determine the impact on project completion schedule, cost, safety, technical performance, and residual risks.

3.5.8.i Provide support for a Safety and Mission Assurance Readiness Review (SMARR) prior to any launch or safety critical event or other activity selected by the Chief SMA Officer.

| [TOC](#) | [Preface](#) | [Change_Log](#) | [Chapter1](#) | [Chapter2](#) | [Chapter3](#) | [Chapter4](#) | [Chapter5](#)
| [Chapter6](#) | [Chapter7](#) | [AppendixA](#) | [AppendixB](#) | [AppendixC](#) | [AppendixD](#) |
[AppendixE](#) | [AppendixF](#) | [AppendixG](#) | [AppendixH](#) | [AppendixI](#) | [AppendixJ](#) |
[AppendixK](#) | [AppendixL](#) | [AppendixM](#) | [AppendixN](#) | [AppendixO](#) | [ALL](#) |

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